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RESIDENCE OF SPECIAL AGENT IN CHARGE.

Issued May 28, 1914.

PORTO RICO AGRICULTURAL EXPERIMENT STATION,  
D. W. MAY, Special Agent in Charge.

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ANNUAL REPORT OF  
THE PORTO RICO AGRICULTURAL  
EXPERIMENT STATION  
FOR 1913.

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UNDER THE SUPERVISION OF  
OFFICE OF EXPERIMENT STATIONS,  
U. S. DEPARTMENT OF AGRICULTURE.

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WASHINGTON:  
GOVERNMENT PRINTING OFFICE.  
1914.

## PORTO RICO AGRICULTURAL EXPERIMENT STATION.

[Under the supervision of A. C. TRUE, Director of the Office of Experiment Stations, United States Department of Agriculture.]

WALTER H. EVANS, *Chief of Division of Insular Stations, Office of Experiment Stations.*

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## LETTER OF TRANSMITTAL.

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PORTO RICO AGRICULTURAL EXPERIMENT STATION.

*Mayaguez, P. R., November 15, 1913.*

SIR: I have the honor to transmit herewith and to recommend for publication the Annual Report of the Porto Rico Agricultural Experiment Station for the fiscal year ended June 30, 1913.

Respectfully,

D. W. MAY,  
*Special Agent in Charge.*

Dr. A. C. TRUE,  
*Director Office of Experiment Stations,  
United States Department of Agriculture,  
Washington, D. C.*

Publication recommended.

A. C. TRUE, *Director.*

Publication authorized.

D. F. HOUSTON,  
*Secretary of Agriculture.*





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# ANNUAL REPORT OF THE PORTO RICO AGRICULTURAL EXPERIMENT STATION FOR 1913.

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## SUMMARY OF INVESTIGATIONS.

By D. W. MAY, *Special Agent in Charge.*

### INTRODUCTION.

There was further progress in agriculture in Porto Rico during the fiscal year 1913, but with the shifting of certain lines. These changes have been in the way of greater diversification and therefore wise. The total value of exports was \$49,103,565.

### SUGAR.

Sugar still holds first place in the industries of the island, the exports for the year having a total value of \$27,226,905. There has been great uncertainty in this industry because of the reduction of the tariff, which will lead in a few years to free sugar and open competition of Porto Rico with the whole world, but the planters and mills have in a measure prepared for this. The growers have in many cases introduced improved varieties of cane, while the fertilization and cultivation of the crop has been vastly improved. On the other hand, lands not well suited to the crop have been planted and others have been continuously planted to cane, so that yields have been reduced to a minimum. Many of these lands will now go out of cultivation. A period of retrenchment is ahead for the sugar industry, and especially for those who have burdened themselves with debt or with contracts made under former conditions. Extreme economy and efficiency must be practised.

### TOBACCO.

Tobacco, especially its manufactured products, makes the second largest item of export. The value of the manufactured tobacco amounted to \$5,824,030, unmanufactured \$3,188,227. There was imported unmanufactured tobacco to the value of \$373,975. Porto Rican tobacco is being improved in quality, finding a larger market, and increasing in price. There is a large population skilled in certain lines of tobacco manufacture, as cigar making.

### COFFEE.

The value of the exports of coffee for the year amounted to \$8,511,316, by far the largest amount since the American occupation. The coffee industry is showing commendable progress. This is due to better cultivation and higher prices. Planters, too, are following better practices in the selection of seed for planting. The station has introduced and grown for distribution Java and other coffees that are yielding better than native coffee and giving a higher percentage of large and uniform grains. This is giving results not only in greater yields but in better prices.

Associations and individuals are striving to obtain better markets and to gain and to hold a higher reputation for Porto Rican coffee. The industry is on a better footing than it has been for years and that, too, without the benefit of tariff or bounties but in competition with the whole world.

Of the coffee exported during the year \$8,378,346 worth went to foreign countries, while only \$132,970 worth went to the United States. The coffee is following the old lines of trade established by tariff laws during the Spanish régime. It is a product whose trade is established upon the preference of taste and is therefore a most difficult one to change. A flavor, a very evanescent thing in a food product, is yet one of the most valuable and one for which the demand is most persistent. To obtain a market for Porto Rican coffee in the United States the preference of a great many people must be changed. The cost is too great to justify this as long as the foreign market demands the Porto Rican product and places it at the top of the price list of coffees from all over the world.

### FRUIT.

The fruit industry shows the most phenomenal increase of any line in Porto Rico. During the year \$2,767,027 worth was exported, of which \$151,681 was canned pineapples. The value of pineapples exported as fresh fruit amounted to \$1,142,007; oranges, \$740,010; and grapefruit, \$726,687.

This is an industry that started from nothing 10 years ago, and as trees already planted come into bearing is sure to increase to a much greater extent. It represents the highest type of intensive farming and is most promising in Porto Rico. To the man with perseverance, industry, and personal supervision it promises good returns. Porto Rico is safe from frosts that threaten the industry on the mainland and is at the open door of the best market in the world—New York and the eastern seaboard.

There has been established a cooperative fruit exchange, which is proving of great benefit to the growers. In the third year of its existence just closed sales through the exchange amounted to

\$568,887. The commission rate before the formation of the exchange was 8 to 10 per cent; the average rate of the exchange has been 6 per cent. Of the capital stock 40 per cent has been paid in cash and 36 per cent more out of the dividends on earnings. After paying 12 per cent annually on the capital stock 75 per cent of the net income is divided pro rata among the shippers, there being now 101 under contract with the association.

Besides selling fruit the exchange imports and sells to members packing boxes and fertilizers, thereby effecting a saving and giving favorable terms of payment. An office is maintained in San Juan, P. R., and in New York City.

The exchange has also resulted in great benefit by bringing the planters into closer cooperation, by inspecting fruit offered for shipment to see that it is ripe and properly packed, and that it is carefully handled in shipping. The greatest good of all, however, has been in bringing allied interests together for mutual good not only in material receipts but in comparing and testing individual results in order to apply them for the good of all.

#### COCONUTS.

The value of exports of coconuts for the year amounted to \$352,390. There is considerable planting of coconuts on the island and there are considerable areas yet where these trees may be profitably set. A coconut grove properly cared for yields a sure and steady income. Better cultivation, the growing of legumes among the trees, the utilization of seaweed and other manures, yield excellent additional returns over cost.

The station has under trial a number of other nut-bearing trees, both edible and oil bearing. Doubtless some will prove profitable for cultivation on the island.

#### LIVE STOCK.

Animals are no longer exported from Porto Rico, but are insufficient for home needs. Besides breeding stock, large amounts of meat and meat products are imported annually. The consumption of meat has increased with more prosperous times. The amount of local production consumed is indicated by the exports of \$187,013 worth of animal by-products—hides, skins, and tallow.

#### MISCELLANEOUS.

Of the minor industries which the station has tried to foster honey production has done well. Since the establishment of the apiary at the station and the teaching of beekeeping in short practical courses apiaries have been placed in many sections of Porto Rico. Honey exports during the year had an aggregate value of \$69,235. No serious



bee diseases exist, and with the inspection law and vigorous quarantine they should be kept out.

Now that sugar is expected to go on the free list in a few years it behooves planters to study diversified farming more than they have ever done before. There is very little unproductive land in Porto Rico and the range of products in such a soil and climate is wide. Every soil here is adapted to the profitable production of some crop. It is the station's business to find the best crop for the different soils and situations.

Besides the various lines of work reported under separate heads, the station has a number of cooperative projects under way. These are conducted with various planters in trials of forage crops, such as alfalfa and introduced grasses; with live-stock breeders in the loan of pure-bred sires; with citrus growers in fertilizer tests in orange groves; with the insular government in planting sisal on dry stony land of the south side; and with the insular fair in getting together exhibits, superintending them, and judging awards.

The agriculturist in Porto Rico is very much handicapped by lack of credit. This is due partly to inheritance of customs and partly to cumbersome and expensive land laws. The legal rate of interest in Porto Rico is 12 per cent per annum and the small holder can not borrow money for less than this rate. In some cases, where he assigns his crop to a mill or commission house, he can borrow money at 8 per cent, but in doing so he ties his hands as regards the sale of his products. The mortgage laws are not bad in themselves. In one respect they are very commendable in that a mortgage can be given to secure a note which is transferable, giving it, therefore, the element of convertibility, and passes readily from hand to hand, but when it comes to notarial fees and the cost of registration the sums are so excessive as to be prohibitive for small loans. This is partly due to the inheritance of old Spanish laws and customs whereby the transfer of land was largely in the hands of the notaries and they and the registrars of property had a very elaborate system of fees that were excessive. Some laws looking to the quieting of titles and the easy registration of evidences of ownership would be highly desirable. The Torrens law, which has worked so well in the Philippines, could doubtless be adapted to the conditions in Porto Rico with great benefit.

During the year a new residence for the special agent in charge was completed (frontispiece), and work was begun on a plant laboratory building that will be better suited to the station's needs than the present propagating house (Pl. I, fig. 1). Both structures were provided for out of funds appropriated by the insular government.

## REPORT OF THE CHEMIST AND ASSISTANT CHEMIST.

By P. L. GILE and C. N. AGETON.

### INTRODUCTION.

The character of the work the past year was the same as in previous years, attention being directed to soils and studies in plant nutrition. Two investigations begun several years ago were completed and progress was made in others still under way. At the last insular legislature an appropriation was made for a plant laboratory for the experiment station. The appropriation will cover the construction and equipment necessary for conducting vegetative experiments in pots on a good scale. This increased equipment should make it possible to extend the scope of the work considerably along some lines.

The cooperative field experiments were considerably increased last year. In the Anasco Valley 35 acres more were laid off in plats on property belonging to the Guanica Centrale. There are now about 140 plats under observation. With the other work under way it is hardly possible to attend to any more plats at present, but it is along the lines of increased field experimentation that the work could be most practically extended.

### NEED FOR A SOIL SURVEY COMBINED WITH FIELD EXPERIMENTS.

To secure a knowledge of the fertilizer and general requirements of all the different soil types on the island will require a tremendous number of field experiments because of the great variety of soils and climatic conditions. An attempt is being made to accumulate such a knowledge of all the soil types, but without special provision for comprehensive work it will take a long time. A soil survey of the island should be made, mapping the areas of the different soil types, and along with the soil survey a series of field experiments should be conducted to determine the fertilizer, lime, and other requirements of the different types of soil in the different climatic localities.

Such an undertaking would necessitate a special appropriation, as it would require the time of another man and involve considerable expenditures for fertilizer and travel. It would, however, be especially valuable. That there is need for such a comprehensive series of field experiments is well shown by the number of soil samples sent to the station with requests for advice as to their fertilizer requirements, etc. Also, the fact that some of the larger agricultural concerns have appointed men to conduct field experiments on their dif-



ferent properties shows that this need for a more definite knowledge of their soil requirements has been appreciated. Of course, a definite knowledge of the requirements of the different soils can only come from definite field experiments. Short methods of determining soil requirements by chemical analysis of the soil, chemical analysis of the crop, or by vegetative experiments in pots, are not reliable when translated to field conditions except in special cases.

At the present time a large amount of money is being lost by using fertilizers where they do not yield an adequate return, and by failure to use them where they would do so. Except in places where direct experiments have been carried on, the use of fertilizers is governed very largely by the selling abilities of the agents of the various brands. Any money spent in learning simply the fertilizer requirements of the various soils would be well invested. Where one corporation is buying \$50,000 worth of fertilizer a year, a 10 per cent increase in the efficiency of the use of the fertilizer would mean a saving of \$5,000.

It is to be hoped that funds may be secured for undertaking a comprehensive system of field experiments in connection with a soil survey.

#### ANALYTICAL WORK.

The analytical work this year has consisted in the analysis of 235 samples of soils, plant ashes, waters, yams, limestones, guanos, fertilizers, molasses, and some miscellaneous materials. Most of the work was done in connection with the investigations noted in the following pages.

Thirty samples of yams, however, were analyzed for the horticultural department, and for the plant pathologist various tannin and nitrogen determinations were made.

#### THE RED-CLAY SOIL OF PORTO RICO.

A report on the red-clay soil has been prepared for publication.<sup>1</sup> This embodies results to date, but does not close the work on this type of soil. The old fertilizer plats at Anasco are being continued, and about 35 acres of new plats have been laid out on another field. The old plats with the ratoon cane will be cut in January, 1914. The appearance of these to date supports the previous results with plant cane in showing that nitrogen is the most essential element for sugar cane on this soil. Also, the beneficial effect of the heavier liming in 1911 is noticeable in the appearance of the ratoon crop.

The new plats, 68 in number, are one-half acre each. They are designed to further test the fertilizer results obtained on this soil and to determine more accurately, if possible, the profit or loss

<sup>1</sup> Porto Rico Sta. Bul. 14.



resulting from applications of different fertilizers and lime. In these plats a comparison of nitrate of soda, sulphate of ammonia, and dried blood is being made to determine which form of nitrogen on this soil is most effective for sugar cane. Each plat is repeated six times, so the results should be definite for the year and soil.

#### CHLOROSIS OF SUGAR CANE.

In 1911 a field experiment was begun at Central Cortada for studying the effect of different methods of applying iron to the chlorotic cane. The plats were cut by mistake before the weights could be obtained, but their appearance before cutting seemed to show that stable manure, stable manure mixed with ferrous sulphate, and spraying with a solution of ferrous sulphate were beneficial, while a simple application of ferrous sulphate to the soil had no effect. The new plats, planned along the lines of the old ones, but on a larger scale, will be cut the first of next year.

The soil samples, taken in the course of the soil survey of the chlorotic areas, have been analyzed for the water-soluble constituents as well as for the acid-soluble. One sample from a chlorotic area at Central Cortada, Santa Isabel, carried nearly 0.2 per cent of water-soluble salts, calculated as sulphates, but contained no normal carbonates. The other samples from chlorotic areas were perfectly normal in their content of soluble salts, corresponding with the check samples from green areas. It is, therefore, evident that the chlorosis is not caused by accumulation of alkali salts in areas of calcareous soil.

Samples of green and chlorotic leaves of the same age have also been prepared for analysis. This work on the ash constituents of the leaves will be carried on next year, analyzing the leaves at different stages of maturity of the cane.

Two crops of chlorotic cane have now been under observation, and certain facts regarding the occurrence of the chlorosis have become apparent. There does not seem to be any definite period in the growth of the cane when it becomes chlorotic. Sometimes cane which has just sprouted is blanched, and at other times the cane is unaffected until it is eight months old. As a rule, ratoons seem to be affected more strongly and generally earlier than plant cane.

All stages of chlorosis have been observed—leaves entirely ivory white, some with only the midrib green, and others with the veins green but the parenchymous tissue colorless, giving a striated appearance. In some cases stools strongly affected with chlorosis die, while in others they become green and grow normally for a time.

The strongly calcareous cane soils and most of the areas of chlorotic cane that have been observed occur in the southern and southwestern

parts of the island, where the rainfall is very irregular and the cane is grown by irrigation. In many cases the chlorotic cane is much improved after a rainy period; in others, however, the new leaves appearing directly after rains have been strongly chlorotic. From the observations thus far it appears very doubtful if the chlorosis is connected with the amount of water available, except that it may affect to a certain extent the factor which is causing the trouble.

It is believed that in some spots where the chlorosis occurs the condition of the cane would be much better if it were planted less deeply; if instead of embedding the seed in the marly subsoil it were planted in the richer surface soil. Of course, the deep planting is practiced on the theory that the cane will better withstand the drought.

As noted in the report for 1911, the areas of chlorotic cane are confined to strongly calcareous soil, but not all such produce chlorotic cane. Thus far it appears that there are some rather small areas that have been planted year after year that have always produced chlorotic cane. There are other fields where some chlorosis occurs every year, but the location varies somewhat with the year. Sometimes isolated stools are chlorotic, but in most cases the chlorosis occurs in definite areas, with the cane strongly affected in the center and partially affected at the edges. Many of the areas are on the slopes of the limestone hills.

#### BAT GUANOS.

But little progress has been made in determining the availability of the nitrogen and phosphoric acid in bat guanos by vegetative means, as the facilities have not been adequate for this work. When the new equipment for running pot experiments is installed, however, this work should go on rapidly.

Many guanos have been sent in from different parts of the island with requests for advice as to how they should be used. These have been tested by a rough quantitative method and the probable value of the material given.

#### EFFECT OF STRONGLY CALCAREOUS SOILS ON THE GROWTH AND COMPOSITION OF CERTAIN PLANTS.

This work, which was started some years ago, has now been completed as originally outlined. Besides pineapples, the study of which was reported in a bulletin of the station,<sup>1</sup> bush beans, radishes, sugar cane, sweet cassava, and rice have been grown on the plats. Each plant was grown six times, and samples of the various crops were analyzed for their mineral constituents.

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<sup>1</sup> Porto Rico Sta. Bul. 11.



The plants varied considerably with respect to the effect of carbonate of lime upon their growth. Bush beans, radishes, and sunflowers, were but little affected. Soy beans made slightly less growth on the calcareous soils than on the check soil. Sugar cane made a noticeably diminished growth in one plat only—that with 18 per cent of calcium carbonate. The growth of sweet cassava was slightly depressed in the plat with 5 per cent calcium carbonate and markedly depressed in the plats with 18 per cent and 35 per cent of calcium carbonate. Rice made a greatly diminished growth on all the plats containing carbonate of lime and was affected with the characteristic chlorosis on these soils.

Some plants showed quite a variation in their ash composition, induced by the carbonate of lime in the soil, while other plants had practically a constant ash composition, irrespective of the amount of lime in the soil in which they were grown. For instance, the extreme variation in the lime content of bush beans from the four different plats was only 3 per cent of the amount of lime present. These results would seem to show that, provided a soil is not absolutely deficient in calcium, it is futile to attempt to increase the lime content of certain fodders by liming the soil.

The detailed results of this work, which throw some light on the tolerance or intolerance of certain plants for calcareous soils, are being prepared for publication.

#### ACTION OF LIME IN INDUCING CHLOROSIS.

Supplementary to studies on the effect of strongly calcareous soils on the growth and composition of various plants, work has been carried on with those plants whose growth is strongly depressed on the calcareous soils to determine by direct experiments as well as by ash analyses how the carbonate of lime injuriously affects the mineral nutrition. Several experiments have been carried on with rice, which has been found almost as sensitive as pineapples to carbonate of lime. The experiments conducted with this plant have been on the following lines: On the effect of gypsum on the growth and composition of rice, the effect of carbonate of lime in depressing the availability or assimilation of iron, and the effect of spraying with ferrous sulphate on rice growing in a soil containing gypsum or carbonate of lime, and in their absence. A report on this work will probably be ready during the coming year.

#### ASSIMILATION OF IRON.

In the course of investigations with rice it has been noted that the iron content of the plant seems to vary considerably with different stages of growth. In order to trace the assimilation of iron, analyses are being made of a crop of rice at 30-day intervals.

## REPORT OF THE HORTICULTURIST.

By C. F. KINMAN.

The lines of work followed in the horticultural department were, for the most part, the same as those reported on formerly. With citrus fruits they included fertilization, stocks, and nursery problems. The vegetable work was confined to variety tests, cultural methods, and fertilizer requirements for yams, dasheens, yautías, and sweet potatoes, the testing of various introductions, and the continuation of experiments to determine the influence of Porto Rican conditions on a number of northern-grown vegetables. Several varieties of mangoes were imported during the year, some through the Office of Seed and Plant Introduction of the Bureau of Plant Industry, others from the bureau of agriculture of the Philippine Islands, and others from individuals in various parts of the West Indies. (Pl. II, fig. 1.) Work with this fruit included variety testing and propagation methods. Cooperative coconut fertilizer experiments were continued in old groves and plans were made for starting similar experiments in groves newly set. Numerous visits were made to various horticultural sections in response to requests from growers for conferences regarding horticultural problems.

### CITRUS FRUITS.

While the cooperative fertilizer experiments with citrus fruits were practically closed a year ago, the plats in which the effect of muriate and sulphate of potash were being compared were continued in the grove near Bayamon. The results in this test were the same as in former years, no apparent differences having been observed resulting from the fertilizers either in the quantity or quality of the fruit or on the general development of the trees. From these experiments it seems that the general belief among Porto Rican growers that muriate of potash is injurious to citrus trees is not well founded.

During the past year the effect of fertilization on the citrus groves throughout the island was more noticeable than ever before. When heavy applications of complete fertilizer were given good crops of fruit were harvested with hardly an exception, and where small amounts or no fertilizer at all were applied the crop was very small. The results of fertilization were quickly shown on the general condition of the trees as well as the amount of the crop. Instances have





FIG. 1.—STATION PROPAGATING HOUSE.



FIG. 2.—TRIAL PLATS, LEGUMINOUS PLANTS.



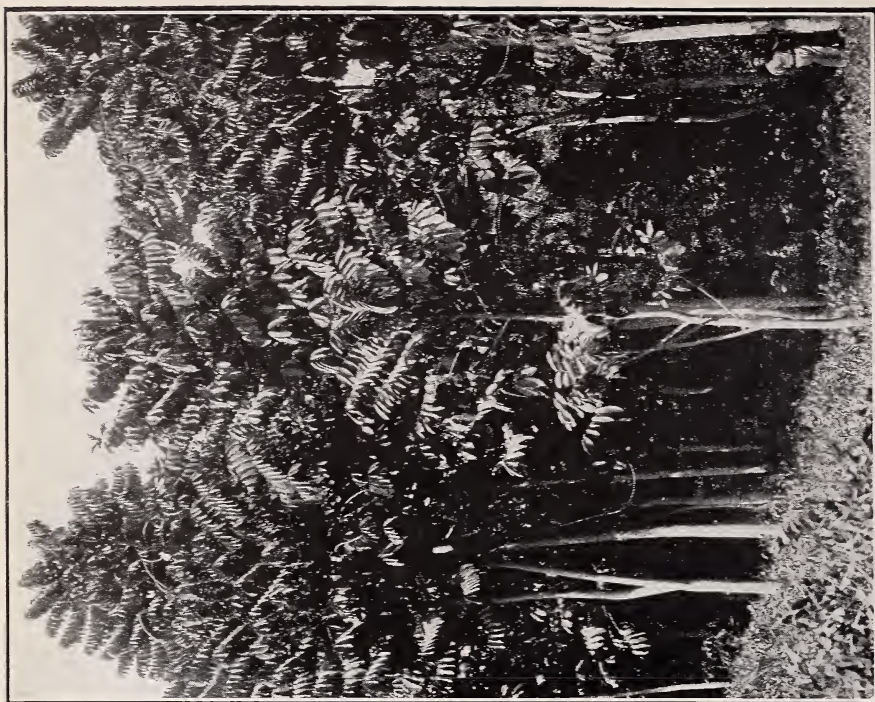


FIG. 2.—CASTILLA TREES 10 YEARS OLD.



FIG. 1.—TOP-WORKED NATIVE MANGO TREE, VARIETY AMINI,  
IN FRUIT.



been noted where one element was omitted in fertilizing and where little or none was given to trees which had in previous years been given sufficient nourishment to support a good crop of fruit. The result has been that the trees are producing small crops, many tips of the branches are dying, and the general condition of the grove is unsatisfactory. This would indicate that where such conditions prevail much of the available plant food has been used and the trees are now more or less dependent on the yearly application of fertilizer.

Applications of fertilizer both complete and incomplete were made in a number of localities and at different seasons relative to the rainy and dry periods in an attempt to influence the blossoming period of the trees. Citrus blossoms may be found any month of the year in Porto Rican groves, and as grapefruit always brings excellent prices during the summer months it is hoped that a method of fertilization may be found which will influence the fruit to ripen during the season of high prices.

As the prices of citrus nursery trees advances from year to year, and the demand is in excess of the supply, a trial nursery has been started to test conditions of the commercial nursery in this part of the island. Seed of well-matured rough lemon and native sour orange were planted during January, 1912, in small beds, where they could be watered, as the open field in this locality is too dry for young seedlings to thrive before May or June; and in June the seedlings were set in the nursery field in rows  $3\frac{1}{2}$  feet apart and 1 foot apart in the row. The field used for the nursery was a low heavy loam, which before planting was given an application of stable manure and a deep plowing. When set out the young seedlings were a few inches tall and in excellent condition for transplanting. During the summer months they grew slowly, due to excessive rains and heavy soil, but through the drier months they made a good growth. The lemon stocks grew faster than the orange and were ready for budding two months earlier. The lemon stocks were budded in May, 11 months after setting, and the grapefruit buds inserted made a good growth, by October being 3 to 4 feet long. The buds inserted into the orange stock have not grown so rapidly.

An application of complete fertilizer was given September 15, 1913, and the nursery has been cultivated a number of times, but aside from this the only attention given the seedlings was a little hand weeding in the row and the necessary pruning, all of the work being done by the ordinary laborers.

From this experience it seems that a nursery can be easily developed in this locality and at an exceedingly low cost; the chief requisites being a well-tilled and well-drained soil, which must be given sufficient fertilizer. For the western and southern parts of

the island, which are subject to winter droughts, and on upland, where at least the surface drainage is good and the soil somewhat exhausted from continuous cropping, the lemon is, on account of its vigor, the most desirable stock. The sour orange, being more resistant to crown and root diseases, is better adapted to low or heavy or poorly drained locations.

### GREEN-MANURE CROPS.

Experiments with leguminous green-manure and orchard cover crops were continued and a number of new varieties tested (Pl. I, fig. 2). Among the most promising of those not before reported on are a few varieties of *Stizolobium* sent for trial by the Office of Seed and Plant Introduction of the United States Department of Agriculture, including S. P. I. Nos. 24657, 32021, and 24424. These varieties, when planted during the dry winter season, produced a fair crop of seed, but made an unsatisfactory growth for a green manure crop. Where planted during the spring months excellent crops resulted. As these crops require several months for growing to maturity, it is desirable to plant them at the beginning or during the wet season and allow them to make a heavy growth, which will serve as a mulch during the dry season. These varieties compared with the common velvet bean and Lyon bean require a longer growing period and, at least on loamy soil, grow more rank. In the locality of Mayaguez these are desirable qualities, as the early maturing legumes allow grass and weeds to spread before the end of the rainy season, during which cultivation is undesirable. The velvet and Lyon beans have, however, proved to be excellent cover crops again this year. The velvet bean ripened seed earlier than the Lyon bean, the first seed to ripen being five months after planting, while the seed of the Lyon bean did not ripen until almost six months. The new introductions did not ripen for a much longer period.

As seed of any of these varieties are liable to decay if allowed to lie on the ground while ripening during a wet season, vines sufficient to produce seed for the succeeding planting should be planted near some other crop over which they can climb. A portion of the field planted thinly to pigeon peas makes an ideal crop for this purpose.

Four and a half months after planting, a cutting was made of a number of varieties of cover crops to determine the weight of the green vines. When freshly cut, it was estimated that the weight of the Lyon bean was 10.48 tons per acre, the velvet bean 10.78 tons, and S. P. I. No. 24657, 10.38 tons. After very thoroughly sun drying, the weight was 2.47 tons, 2.45 tons, and 1.66 tons, respectively. The heavier dry weight of the Lyon bean and velvet bean is accounted for by these being more mature and having formed seed pods.



As these crops are rank growing climbers, they are sometimes troublesome in groves as they climb over trees, but for a green manure in rotation with pineapples or on an otherwise unoccupied field they are an ideal crop.

During the past two years the sword bean and pigeon pea have been tested as nitrogenous manure crops and cover crops with pineapples by planting them in the pineapple beds. Four row banks of both Red Spanish and Cabezona varieties were used, two rows of the legumes being planted in each bank at the time of setting the pineapples, the number of leguminous plants being about equal to that of the pineapples. One portion of the field was left as a check. In one portion the legumes were cut and laid on the ground under the pineapple plants at the beginning of the dry season, about December, and not replanted until the first of the rainy season the following spring, and in the other portion they were replanted as soon as they matured seed, so there was a growing crop throughout the year. Where pigeon peas were allowed to grow throughout the year, the Cabezona variety made practically no growth, and where they were removed at the first of the dry weather, the pineapples made a poor development. The effect of the sword bean was much less marked up to the end of the first half year, the legumes seeming to have been a benefit to the pines. At the end of 18 months the injury caused by the legumes was very apparent, the pineapple plants being much more slender than the check plants.

The effect on the Red Spanish variety was less marked, though under all conditions injurious. At the end of the first year the sword beans seemed to have been a benefit to this variety and the pigeon peas but a slight injury, but by fruiting time the injury caused by both legumes was marked. Where the sword beans had been allowed to grow during the wet season only, the injury was the least, and most where the pigeon peas grew throughout the year. The pigeon peas were more injurious than the sword beans in every case.

#### COCONUTS.

The cooperative fertilizer experiment started in June, 1912, is being continued. During the past year four pickings of fruit were made, the last 16 months after the first application of fertilizer. Neither in the trees nor in the number or diameter of the nuts has the fertilizer thus far shown its effect. These results are to be expected, as old coconut trees seldom show any effect of fertilization under two and one-half years. As the grove in which this experiment is being conducted is situated on a typical Porto Rican coconut soil and due to age and close setting of the trees the crop of nuts is light, decisive results may be expected within a few years.

An examination in the experimental plats shows that the soil is a mixture of coral and silica sand with a small amount of humus near the surface. In the upper 6 inches of soil small fibrous roots are very numerous. From this depth to 16 inches there are many small and a few large roots. From 16 to 22 inches large roots are very numerous, and below this there are only occasional large roots going down to the water level, 3 to 5 feet below. Samples of soil were taken at a number of points in the coconut grove and at various depths, including some at sea level, for examination to determine the amount of salt in the soil water. No appreciable amount of salt was found except in borings within a few yards of the sea. As the samples were taken after several months of comparatively dry weather, it seems probable that salt is not carried far inland by underground seepage from the sea and is not so necessary for the development of coconuts as is sometimes thought.

While the land best suited to this crop in Porto Rico is taken up for the most part, there are still unplanted areas which would produce well, and as but little culture has been given to the groves there is opportunity for both extension and improvement of the industry.

#### **DYNAMITE FOR LOOSENING SOILS.**

Dynamite for loosening soil and facilitating drainage has been used in a number of places in Porto Rico, both in land devoted to citrus trees and to pineapples. While no experiments with it have been conducted on the station farm, observations were made in a number of places over the island where it has been tried. The principal use to which dynamite has been put in citrus lands during the past two years is in loosening the soil at the point where a citrus tree is to be set, for which purpose those who have used it claim it of benefit. Where it has been tried in old groves and in pineapple fields no improvement has been noted that can be attributed to it.

Where half-pound sticks were discharged three years ago 3 feet below the surface and 25 feet apart in an orchard of grapefruit which was several years old, no beneficial effects are yet apparent. In the part of this grove where the dynamite was tried the soil is sloping and in texture a heavy red sandy clay with a very heavy subsoil which drains poorly. This trial was made at a time when the surface soil was dry, though the subsoils of this type are always moist. Immediately after the discharges were made an examination showed that there had been formed a spherical opening about 1 foot in diameter at the point of the explosion the wall of which was broken by a network of cracks from one-eighth to three-eighths of an inch in width and the soil within several inches of the opening was packed much firmer than the surrounding soil. The cracks

could be followed laterally from  $2\frac{1}{2}$  to 4 feet. About 3 square yards of soil above the charge was well loosened and raised a very few inches by the explosion.

Examinations have been made in this dynamited area a number of times, and the soil appears not to have drained any better, if as well, as has that near by. This condition might be expected, as the charges were placed so far apart that cracks caused by one explosion did not meet those of the next explosion, and the subsoil water could not drain from one loosened area to the next. It seems probable that the opening and cracks made by the explosion were filled with water during the rainy season, which, being held by the surrounding soil unbroken by the dynamite, left the water content highest at these places.

Where there is a substratum which can be broken through or the charges are placed so as to afford subsoil drainage from one loosened area to the other, dynamite should prove a very great benefit to our heavy soils, as poor subsoil drainage is one of the greatest hindrances to citrus culture in Porto Rico.



## REPORT OF THE ASSISTANT HORTICULTURIST.

By T. B. McCLELLAND.

### COFFEE.

The coffee crop of the past year was the largest since the American occupation of the island, and in American gold its value was the greatest of any Porto Rican coffee crop in the history of the industry. A few such years would bring most decided prosperity to the coffee growers.

The plantings of Porto Rican coffee at the station are not being enlarged, but plantings of promising foreign varieties are being made of sufficient extent to serve as valuable tests. A recent addition, which it is thought may prove of value, is San Ramon coffee from Costa Rica. This coffee is said to thrive in exposed situations and under conditions very unfavorable to the ordinary Arabian coffee. If it lives up to its reputation it will prove a most valuable acquisition. There are several hundred thrifty young plants of this variety now in the nursery beds.

Nearly an acre was planted to *Coffea dewevrei* and plants were distributed to numerous coffee planters over the island for tests. Additional plantings were also made of *C. liberica* and *C. laurentii*. The latter is now being very extensively planted in Java.

The cultural, shading, pruning, liming, and fertilizer tests are being continued. In fertilizer tests in some cases very striking differences have been noted, but before definite results with fertilizers can be obtained more time must elapse and there must be more duplications of the tests to verify results. Stable manure is undoubtedly very beneficial. In one planting the trees which had received an ample allowance of stable manure gave double the yield obtained from the check plats.

A number of coffees which had not hitherto borne blossomed this spring, among them *C. laurentii*, *C. canephora*, *C. stenophylla*, *C. abeokuta*, Leroy coffee sometimes classified as *C. laurina*, and several coffee hybrids and crosses.

The trees of the columnaris coffee are at present loaded with a heavy crop. This variety differed from other coffees at the station in that until it had made a large well-developed tree almost no fruit was produced. If it continues to bear as at present it will likely prove a most valuable coffee for the island.

Many requests for coffee seed were filled in the autumn.



A very good method of handling the guamá ant, *Myrmelachista ambigua* subsp. *ramulorum*, which is so troublesome in coffee, has been found where colonies occur only in isolated guamá trees, as is sometimes the case. Eleven such trees had all of the younger growth and smaller branches removed and burned immediately. The trunks were then banded with tanglefoot. In this way a large part of the ants was destroyed and practically all of the large fleshy pink scale on which they feed. A month later, on some trees no ants whatever were seen, on one the ants were dying and a fungus was seen on them, while on others the tanglefoot had been bridged. Though the ants continued to live for a while on some of the trees, they eventually disappeared from all of those treated.

#### CACAO.

Beginning January, 1913, a record is being kept of the individual yields of all of the surviving trees of the cacao planting of 1903. These vary extremely, in one picking running from 1 to 26 fruits. As numerous pickings are made throughout the year the individual yields for the whole season show wide differences in the trees in regard to productivity. Through this record it will be possible to make accurate selection of the most valuable trees for propagation. Only about two out of every three trees are producing. Considering only those producing, the yield for the year ending December, 1912, averaged a fraction less than 10 pods per tree, or nearly four-fifths of a pound of marketable cacao. Though mature pods may be found at any time, there is always a very noticeable increase in the late spring and late autumn pickings.

Cacao now brings 14 cents per pound in the local market, which is a considerably better price than formerly.

#### VANILLA.

The size of the vanillery was very considerably increased and a sufficient number of plants of *Vanilla planifolia* have now been started to serve as a valuable test of its commercial prospects under local conditions. The vines are placed under varying conditions of sun and shade and the needs of the plant in this respect will be studied. Heretofore the prospects for fruit have been largely sacrificed to furnish material for cuttings. From now on the vines will be pruned only when advisable for their welfare and all their energy will be directed toward fruiting. The first crop of pods of *Vanilla planifolia* from plants received from the Subtropical Laboratory at Miami, Fla., in December, 1909, was matured in the fall of 1912. The longest pod was 8½ inches in length.

*Vanilla pompona* has made a great growth of vine but has failed to blossom this year. *Vanilla* sp., "Pompón," S. P. I. 14540, from

Vera Cruz, Mexico, has blossomed for three seasons. The blossoms were close-pollinated the first two seasons. Fruit set but all fell without maturing. This season some blossoms were close-pollinated while for others pollen was applied from flowers from a different raceme of the same plant. Both lots of blossoms set fruit but all fell without maturing. Some of the Panama vanillas have grown luxuriantly and are bearing well. They are all of the thick-podded type,  $6\frac{1}{2}$  inches being the greatest length of pod so far produced.

#### RUBBER.

Monthly tappings are being made of 38 of the 10 to 11 year old Castilla trees, running from  $24\frac{1}{2}$  to 40 inches in girth at 3 feet above base. (Pl. II, fig. 2.) The tapping is done with an inch and a half chisel, there being cut per tree four vertical rows each of seven horizontal cuts. The latex is allowed to coagulate on the tree and on leaves spread at its base to catch the overflow. It is collected the next day as scrap rubber, washed, and pressed into a cake. The rubber collected from the leaves in eight tappings varied in weight approximately from one-fifteenth to four-fifteenths of the whole. For the eight tappings the average yield per tree per tapping was a little less than half an ounce of rubber. A sample was sent to the editor of the India Rubber World, who pronounced it "in quality along with the best and toughest Castilla rubber that the market sees."

#### COFFEE AND CACAO IN VENEZUELA.

In April a trip was made to Venezuela to study plantation practices in coffee and cacao production and to bring from there plants of economic or ornamental value.

The coffee plantations visited were chiefly on level land affording cultural possibilities that were not taken advantage of. The best were irrigated, and those without water were suffering severely from drought. The spacing of the coffee was slightly wider than that generally practiced in Porto Rico. Near Caracas were seen some coffee trees still productive, said to have been planted about 1778, the first coffee trees in Venezuela. In the coffee plantations a very heterogeneous shade is used, though the preferences are for *Inga* for high lands and *Erythrina*s and *Pithecolobium saman* for low. As *Inga fastuosa* is not known to have been introduced into Porto Rico, though extensively used in Venezuela, seed were obtained of this and of several species of *Erythrina*, and of all there are now thrifty plants set in the station plantings of coffee and cacao.

Various cacao estates were visited, including those of Chuau, where the finest cacao in the world is said to be grown, selling at  $33\frac{1}{2}$  to

34½ cents a pound. From these estates an attempt has been made to eliminate as much as possible the trees producing seeds of a dark purple color in section, and to propagate only from those which are white to pale pink or lavender in section, as the latter are much less bitter in flavor. The practice of coating the cacao with earth of a brick-dust color is quite universal. It is claimed that this better preserves the cacao. This process of course adds some weight and makes a product of uniform and pretty appearance.

The cacao trees are spaced at about 12 feet each way. Their branch system is kept quite low, which much facilitates the gathering. The plantations are shaded and irrigation is practiced.

As a windbreak, *Anacardium rhinocarpus*, a wild cashew, which attains gigantic size, is used to some extent. Seed of this and pods of several of the choicer varieties of cacao were brought back. Seeds or plants of valuable hardwood forest trees, promising varieties of vegetables, and of various ornamentals not found in Porto Rico were also secured, and a large collection of orchids was made in a trip through the virgin forest.



## REPORT OF THE PLANT PATHOLOGIST.

By G L. FAWCETT.

### CACAO DISEASES.

The work with cacao diseases was carried so far that some definite conclusions are possible, some of which are included in this report. The work having been interrupted, it seems well to present some of the results without waiting until a more complete report is possible.

Cacao is not an important crop in Porto Rico. It is grown quite generally, however, though evidently less than formerly. There are few coffee plantations without some of these trees. They receive the same care as that given the coffee trees among which they grow, that is, the ground about them is weeded occasionally if the shade is not sufficient to make this unnecessary. That old neglected trees should be diseased is to be expected. But diseases are also very common among the well-cultivated trees belonging to this station where this work was carried on.

The black pod disease of Porto Rico, which is distinct from the disease generally known by that name, is confined to young fruits, principally to those of 12 centimeters or less in length, although larger fruits are sometimes affected. The trees during the fruiting season bear many brown or blackened pods which conspicuously mark its presence. In the case of the green varieties the first symptom is the taking on of a lighter or yellowish color. Later the pods become somewhat flaccid, yellow, and then become brown, the browning beginning at either or both ends, often appearing also very soon in the longitudinal depressions. Then the pod blackens and shrivels, but remains hanging to the tree. Later, various fungi appear on the fruit. In the case of the varieties with red pods the same thing takes place, the preliminary loss of chlorophyll being somewhat concealed by the red coloring matter.

The loss apparently is great, as on many trees not more than 5 per cent of the fruits that set reach maturity. It is to be noticed that although all the fruits of young or weak trees blacken, the larger and older trees always bear some good pods. The pods that develop are generally situated on the trunk and larger limbs. It is also to be observed that if more than one fruit is borne on a cushion, although all may become several centimeters long, they die off gradually, beginning with the smallest until but one or, rarely, two are left. The symptoms are always the same whether the fruit is one of the small ones near the end of the branch or in the cushions

of larger fruit on the trunk. This behavior of the disease, with reference to the situation of the fruits and their proximity to other fruits, suggests that food supply is the controlling factor in determining whether they mature.

To find what relation, if any, might exist between fungi and bacteria and this failure of the pods to mature, numerous cultures were made with material from the interior tissues, this being selected from various parts of the fruits. From fruits showing the first symptoms of the disease no organisms were obtained, their interior tissues being found to be free from both bacteria and fungi. This was also found to be true of many fruits that had become quite brown. Occasionally a *Glœosporium* developed in cultures from these, and the same fungus was obtained frequently from the more advanced stages. This *Glœosporium* in cultures appears identical with that obtained from cultures from the spores of a *Colletotrichum* which produces an anthracnose of the pods, which is characterized in its earlier stages by sunken brown spots on the pod and which is occasionally to be found, though it is not common. This fungus agrees fairly well with the description of *C. cradwickii*. In sterile culture chambers after being sterilized externally by moistening with alcohol and placing in 4 per cent formalin for 30 minutes and then washed in sterilized water, *Glœosporium* developed in about one-third of the fruits with blackening tips, and not in those that were merely yellow. With less thorough disinfection *Fusarium* of two types and occasionally *Nectria bainii* developed on some of the fruits.

To test the parasitism of these fungi by inoculation into fruits on the tree and of the same size and age as the ones commonly diseased is difficult, for the reason that all the check fruits invariably succumbed, as well as all those into which inoculations were made, without regard to the nature of organism used. All the species isolated were inoculated into larger healthy fruits which gave promise by their size and color of being able to mature. On these fruits the inoculation with all the fungi failed to take except those with the *Colletotrichum*, which, when spores were introduced into small wounds made with a scalpel and covered with adhesive tape, sometimes resulted in the formation of small black spots from which the fungus could be reisolated. When merely applied to the surface or into very small wounds made with a needle, no spots were formed.

An attempt was made to increase the number of fruits maturing by spraying the trees with Bordeaux mixture. The spraying, although repeated frequently, had no effect, the sprayed trees yielding no more pods than the unsprayed. The spraying was carried on for two seasons. A further test of the effect of fungicides was made by applying the spray by means of a hand sprayer to certain fruits from the time they had reached a few millimeters in length so fre-



quently that they were always protected by a coating of the spray. In addition to Bordeaux a one-half per cent solution of carbolineum and a similar dilution of iron chlorid were used, the latter to see if it would correct the tendency to loss of chlorophyll in the fruits as it is known to do in chlorotic leaves, but this treatment also failed to show beneficial effects.

The work up to this point would indicate that the trouble is not due to parasitic fungi, this being indicated by the freedom of the fruits from fungi in the earliest stages and the fact that the commonly present *Colletotrichum* is but weakly parasitic. The result of the sprayings confirms this idea. It would seem that this so-called disease is caused, at least in part, by the trees setting more fruit than they are capable of supplying with food materials, the result being that the weaker and younger fruits die. A similar phenomenon is occasionally to be seen in grapefruit groves, only in the latter case the fruits fall and the effect is not so noticeable. The superfluous cacao fruits do not fall, but adhere for some weeks, become black, and give the tree a rather alarming appearance, suggesting the ravages of disease.

Those of the diseased fruit which happen to be infected with the *Colletotrichum* could possibly be regarded as affected with the "Jamaica pod disease" (*C. cradwickii*), in which case that fungus is clearly not a dangerous parasite. In its attacking young fruits and in the blackening resulting therefrom, the black rot disease of Trinidad and other West Indian islands most closely resembles this Porto Rican cacao disease. That such a resemblance exists, at least in its later stages, is also affirmed by persons familiar with both the Porto Rican disease and the black rot. This would suggest that all the injury ascribed to the undoubtedly parasitic fungus of the black rot is not necessarily caused by that fungus. If conditions elsewhere resemble those of this island, many of the fruits would be lost without the action of any fungus. *Phytophthora faberi* has not been found in Porto Rico.

The effect of fertilizers on the trees, with regard to lessening the number of fruits that fail to mature, is being tried in cooperation with the assistant horticulturist. It seems probable that although such fertilizing may increase the vigor of the trees, and thus the yield of good pods, the ratio of the number of such pods to the number of those remaining undeveloped can not be materially changed.

Early in the work some attention was paid to the insects, aphids and mealy bugs with ants being very common. Protection from these insects by means of wire cloth and by using insecticides was without beneficial effect, as many fruits dying on the protected as on the unprotected trees. Any injurious effect from these insects must be very small. In any event, it has nothing to do with the failure of the fruits to develop.



## CITRUS DISEASES..

In the work with these diseases an interesting result was obtained with regard to the lemon scab. The fungus producing this disease attacks the grapefruit when quite small, producing wart-like outgrowths which greatly disfigure the full-grown fruit, causing it to sell at a lower figure. The disease is very common, so that it often seems merely a question of a suitable host as to whether or not it makes its appearance in the grove. Such general distribution would indicate the possibility of its having other hosts than the citrus trees or that other fungi than the *Cladosporium* usually found on the lemon cause the trouble.

What are apparently other species of this fungus are common on the wild plants found in many of the groves as well as on the legumes grown as cover crops. The gandul, a legume often grown as a temporary windbreak for young plants, was so often found near the worst diseased plants as to suggest that a *Cladosporium* causing spots on its leaves could have something to do with the trouble. Inoculations made with this fungus on young grapefruit produced warty outgrowths, and young lemon plants similarly inoculated have developed scab identical in appearance with that produced on lemon leaves by *C. citri*. The *Cladosporium* of the gandul differs somewhat in appearance from that of the lemon, but they may later be shown to be identical. Inoculations with species of *Cladosporium* of other plants are being made. It seems clear that the scab of grapefruit may, in many instances, be due to infection from the gandul. Should it be shown that scab-producing fungi are quite common on other plants, the importance of clean cultivation in avoiding this disease would be evident.

## COFFEE.

The diseases which cause the coffee grain to be classed of lower quality and make its preparation more difficult have been studied. Of these, the one caused by *Cercospora coffeicola* seems to be the most harmful. This fungus has hitherto been considered a leaf parasite of small importance. The injury resulting from its attacks consists, in part, in causing the grain to be more difficult to prepare. It also causes the grain to become black and shriveled. The effect of the disease in shaded and unshaded trees has been studied, and the relative proportion of bad grains in coffee from trees under various conditions has been established by determining the proportion of such grains in numerous samples. The injurious effect of sunlight on the trees has been generally recognized, but it would seem that its effect on the quality of the grain, through its producing conditions favoring the development of this fungus, is equally bad.

## REPORT OF THE ANIMAL HUSBANDMAN.

By E. G. RITZMAN.

The fact that weather and soil conditions in the neighborhood of Mayaguez are very unfavorable for stock raising has necessarily forced the station to carry on more of its work of breeding in cooperation with stock growers more favorably located in this respect. This policy has, however, been compensated by the greater interest stimulated through such direct contact. The chief lines of cooperation in the past included work with horses and cattle, mentioned in previous reports, and African woolless sheep. During the year similar experiments were begun with the more promising introductions of the grasses obtained from the Bureau of Plant Industry and more especially with alfalfa. The chief object sought in this work is to obtain suitable legumes for forage as well as good drought-resisting grasses.

### HORSE BREEDING.

The station had only three horses during the year. The saddle-bred horse, Black Badger, which was brought down last year, was placed in a stud near Coamo. The Morgan colt, Edmunds, made a fair development at the station. He is now going on 3 years and will be used lightly for stud work next year.

The oldest colts sired by horses formerly owned by the station are now going on 3 years and by next year will give some definite idea as to their ultimate value for carriage use. Comments made in the last report on these colts seem so far fully substantiated, and further report will be made next year when they are broken and more nearly mature.

### CATTLE BREEDING.

The chief line of work with cattle during the past four years has been with Zebu blood on native cattle. The primary object has been to increase the working efficiency of the draft ox. The bulls used in this experiment were obtained by crossing pure-bred Zebu sires of one of the largest and most improved breeds of India on Shorthorn and Hereford cows. These bulls, now fully developed, are magnificent specimens. (Pl. III, fig. 1.) They stand about 68 inches at the hump. The Shorthorn and Hereford blood has broadened the frame somewhat and given more depth of body than is usual in the pure-bred Zebu. It has also given a tendency toward earlier maturity. These factors are an asset as a beef proposition. Fortunately the



chief factors for tropical consideration which are characteristic of the pure Zebu have been fully retained. Those characteristics consist of exceptional constitutional vigor, active movement, strong bone, straight legs, hard hoofs, and a straight, easy, and rapid gait. Equally important Zebu characteristics, however, are almost complete immunity to tick infestation, together with natural adaptation to tropical heat and short pasturage.

The progeny of these bulls from Porto Rican cows now number over 300 head, of which some are just 2 years old, some yearlings, and some suckling calves, about equally divided in number. (Pl. III, fig. 2.) The consensus of opinion among breeders who bred them and who have been engaged in breeding native stock for years is the best criterion of their value compared with native stock. This opinion, which refers only to growing stock, is summed up as follows: The newborn calves are larger and stronger; yearlings and 2-year olds are larger and keep in better flesh on short pastures; they carry practically no ticks, which undoubtedly permits them to keep in better flesh as they loose less blood; they keep in excellent health, are vigorous and thrifty, and show strong indications of some advance toward earlier maturity.

They possess the general essentials already described in their sires. There is apparently a relation between the black skin with light-colored short hair and the Zebus' adaptability to tropical conditions. In support of this Wallace's observations "that cattle having only a fraction of Zebu blood never stand in water to get relief from heat" are borne out here, which certainly is in marked contrast to the habits of American and European breeds. The shortness of coat, which leaves even small seed ticks almost entirely exposed, is undoubtedly a strong factor in keeping them free of ticks, and it is to this that successful stockmen here pay a great deal of attention. Jerseys and other breeds, which also have short hair, carry fewer ticks than those with long hair, but they are much more subject to infestation than cattle with even a small fraction of Zebu blood, which suggests that the Zebu skin has some repellence to the parasite.

The dairy herd at the station now consists of five crossbred Shorthorn native cows, one pure-bred Jersey, and two pure-bred natives. In addition to this there are two heifer calves which are three-quarters Shorthorn and one-quarter native. The Jersey has kept in good health and, though subject to tick infestation, has done well as a milker. Of the natives, one is a fair milker and one very inferior. The Shorthorns, four of which are now in milk, give small promise of dairy improvement, but are undoubtedly superior for beef. The half-breds are not troubled with ticks seriously, as their coats are comparatively short. The three-quarter bred have the long woolly coat of the Shorthorns, and are almost as subject to tick



infestation as pure breds. These are very important considerations here, and show that in combining improved foreign blood for dairy improvement the purely tropical characteristics should not be lost, as the lack of natural adaptation will prevent even high-yielding cows from attaining maximum efficiency.

### SHEEP.

Sheep-breeding operations were abandoned at the station owing to the difficulty experienced in keeping the animals in good health in this locality. Over half the lambs dropped were lost annually from the effect of flukes, which are a constant menace during the rainy season. Of the African woolless sheep mentioned in previous reports of the station, a few flocks have been started on the south side of the island. The largest of these was begun with a male and two females sent by this station three years ago to test their adaptability under more suitable soil and weather conditions. This flock now numbers 60 head, 40 more have been slaughtered or sold, and none have been lost by disease. While wool sheep here have been affected with scab, none has ever been seen on the African sheep although they grazed with the affected sheep. The African sheep breed at any season here after one year of age, and almost without exception drop twins. This flock, which pastures on limestone soil, has kept in splendid health and flesh during all seasons of the year.<sup>1</sup> They carry a good leg of mutton and are fairly well fleshed over the back. The flavor and quality of their meat is not excelled by any of the mutton breeds. They are naturally adapted to this latitude and need improvement only by adding some additional flesh. They are essentially a tropical breed, even more so than the Tunis sheep.<sup>2</sup> Their advantages for a hot tropical climate is a black skin which permits of rapid radiation of excess body heat, and a yellowish brown coat of hair which is a good reflector of heat and light rays. While improvement for better mutton form by selection would be slow, yet it would no doubt be safer than by crossing, as the introduction of new characters by a Temperate Zone breed would also probably tend to lessen their adaptability to tropical conditions. The standard of health which they now maintain enables them to keep in better flesh than breeds not so well adapted, and their extreme fecundity, together with a natural instinct to browse, gives a valuable animal for the utilization of lands not suitable for cattle but otherwise favorably located.

<sup>1</sup> The writer has seen these same sheep as far north as Washington, but though they seemed to keep in excellent health there they did not carry as much flesh as they do on the south side of Porto Rico, probably because they were out of their natural habitat.

<sup>2</sup> Tunis sheep, which are woolled, are often regarded as a tropical breed, an erroneous impression, as Tunis, though a mild and well tempered country as regards climate, is above latitude 30° or well within that of the Southern States, not including the peninsula of Florida.



FIG. 2.—CROSSBRED CATTLE—HALF-BRED ZEBU AND NATIVE COWS.



FIG. 1.—HALF-BRED ZEBU BULL AND CALF.





### FORAGE CROPS.

In addition to those forage crops mentioned in the last report some additional varieties, principally grasses, were obtained from the Bureau of Plant Industry of the United States Department of Agriculture. Part of the seed was planted in field plats and part in seed boxes, where better control could be kept.

*Tricholæna rosea* promises to be very productive, as it grows quickly and forms a dense stool. The varieties of *Kerstingiella* are slow growers and produce very little forage here. Their growth at Mayaguez is so inferior as to promise little either for forage or soil renovation.

A beginning has been made toward the improvement of the native corn. About an acre has been planted and harvested. Half of this area was planted from selected kernels and the other half from unselected for comparison. The difference in germination was 8 per cent in favor of the selected seed. There was also a difference in appearance and yield in favor of the selected seed. Selected seed produced nearly 12 per cent more corn and 6 per cent more fodder. Corn is now one of the chief fodder crops in Porto Rico. The native variety is so inferior in shape of ear and grain that with systematic selection the yield should be doubled.

Efforts to grow alfalfa have been begun in cooperation with planters on the south side of the island, which is the section probably best adapted to its growth. The station furnished the seed and supervised planting. Six plats, ranging from  $\frac{1}{10}$  acre to 2 acres, have so far been seeded. Incidentally small seed plats of the various grasses were also established with each alfalfa plat.

### MISCELLANEOUS.

The development of the poultry industry in Porto Rico is still somewhat hampered by the high price of feeds, practically all of which is now imported ready mixed. The price of scratch feeds has been approximately \$2.75 per hundred pounds and of mash feeds about the same, the cost varying in different localities. Samples of scratch feed have been obtained from poultry feed manufacturers in the States and examined as to their ingredients. Four representative scratch feeds were composed of corn, wheat, oats, sorghum or Kafir corn, barley, buckwheat, bone, sunflower seed, charcoal, and weed seed.

Seventy-five per cent of the ingredients in some of these feeds can be easily grown or produced in Porto Rico. This includes corn, sorghum, sunflower seed, charcoal, and bone. Oats can be purchased for less than \$2 per hundred pounds, while buckwheat and barley

can be omitted without a lack of variety in the mixture. This leaves only wheat as a necessary part of the mixture which is not available here. A greater utilization of locally grown products would no doubt effect a reduction in the price of poultry feeds. It has also been the practice at the station to prepare poultry mashes. While all the ingredients are imported products, yet some saving has been made by buying them separate and making the mixture. The standard mixtures used cost about \$2.35 per hundredweight and are made up as follows:

*Rations used for poultry at station.*

Ingredients.	Ration No. 1.	Ration No. 2.
	<i>Pounds.</i>	<i>Pounds.</i>
Corn meal.....	200	100
Wheat shorts.....	200	100
Bran or wheat middlings.....	200	200
Beef scraps.....	100	75
Total.....	700	475
Nutritive ratio.....	1:3.2	1:2.9







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